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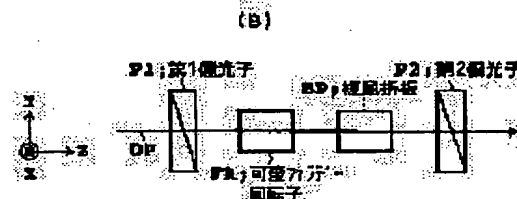
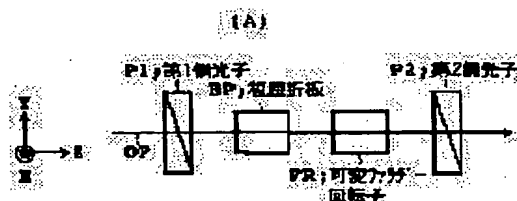
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(54) VARIABLE OPTICAL FILTER

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a variable optical filter by which the shape of a characteristic curve representing wavelength characteristics of transmissivity varies along an axis of transmissivity.

SOLUTION: This filter consists of 1st and 2nd polarizers P1 and P2, a birefringent element BP which has an optical axis determining a phase difference given between two transmitted orthogonal polarized components, and a Faraday rotator FR which gives a variable angle of Faraday rotation to the transmitted polarized light, and the array order of the birefringent element BP and Faraday rotator FR and the relative position relation between the optical axis and the axis of transmission of the respective polarizers are so sets that the shape of the characteristic curve representing the wavelength characteristics of the transmissivity varies along the axes of transmission as the angle of Faraday rotation varies.



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CLAIMS

[Claim(s)]

[Claim 1] The 1st which has the transparency shaft which determines the polarization shaft of the polarization penetrated respectively, and 2nd polarizers, The birefringence element which has the optical axis which determines the phase contrast which is established between the above 1st and the 2nd polarizer, and is given between the rectangular cross 2 polarization components to penetrate, It has the Faraday-rotation child who is prepared between the above 1st and the 2nd polarizer, and gives an adjustable Faraday-rotation angle to the polarization to penetrate. The relative location of the array sequence of the above-mentioned birefringence element and the above-mentioned Faraday-rotation child, the above-mentioned optical axis, and each above-mentioned transparency shaft is a good light variation study filter set up so that the configuration of a characteristic curve of giving the wavelength property of permeability may change to the shaft orientation of permeability according to change of the above-mentioned Faraday-rotation angle.

[Claim 2] the band where it is a good light variation study filter according to claim 1, input light was supplied to the 1st polarizer of the above, and the above-mentioned input light was defined beforehand — having — **** — eye this ** — laws — a good light variation study filter with a **** band smaller than one half of the wavelength width of face which gives the period of the above-mentioned characteristic curve

[Claim 3] It is the good light variation study filter with which it is a good light variation study filter according to claim 1, input light is supplied to the 1st polarizer of the above, and the 2nd polarizer of the above consists of a partially polarized light child.

[Claim 4] Are a good light variation study filter according to claim 1, and the above-mentioned Faraday-rotation child is prepared between the above-mentioned birefringence element and the 2nd polarizer of the above. Input light is a good light variation study filter with which it is satisfied of $\phi! = n\pi / 2$ (n is an integer) when setting to ϕ the angle which passes in order of the 1st polarizer of the above, the above-mentioned birefringence element, the above-mentioned adjustable Faraday-rotation child, and the 2nd polarizer of the above, and the transparency shaft of the 1st polarizer of the above and the optical axis of the above-mentioned birefringence element make.

[Claim 5] It is a good light variation study filter according to claim 4, and the above-mentioned angle ϕ is a good light variation study filter equal to $\pi/4$.

[Claim 6] It is a good light variation study filter according to claim 5, and the above 1st and the transparency shaft of the 2nd polarizer are an parallel good light variation study filter mutually.

[Claim 7] It is a good light variation study filter according to claim 5, and the transparency shaft of the 2nd polarizer of the above is a good light variation study filter parallel to the optical axis of the above-mentioned birefringence element.

[Claim 8] It is the good light variation study filter with which it is a good light variation study filter according to claim 4, and the above-mentioned angle ϕ differs from $\pi/4$.

[Claim 9] The good light variation study filter further equipped with $1/4$ wavelength plate which is a good light variation study filter according to claim 4, and is prepared between the 1st polarizer of the above, and the above-mentioned birefringence element.

[Claim 10] Are a good light variation study filter according to claim 1, and the above-mentioned Faraday-rotation child is prepared between the 1st polarizer of the above, and the above-mentioned birefringence element. Input light is a good light variation study filter with which it is satisfied of $\theta = n\pi/2$ (n is an integer) when setting to θ the angle which passes in order of the 1st polarizer of the above, the above-mentioned Faraday-rotation child, the above-mentioned birefringence element, and the 2nd polarizer of the above, and the optical axis of the above-mentioned birefringence element and the transparency shaft of the 2nd polarizer of the above make.

[Claim 11] It is a good light variation study filter according to claim 10, and the above-mentioned angle θ is a good light variation study filter equal to $\pi/4$.

[Claim 12] It is a good light variation study filter according to claim 11, and the above 1st and the transparency shaft of the 2nd polarizer are an parallel good light variation study filter mutually.

[Claim 13] It is a good light variation study filter according to claim 11, and the transparency shaft of the 2nd polarizer of the above is a good light variation study filter parallel to the optical axis of the above-mentioned birefringence element.

[Claim 14] It is the good light variation study filter with which it is a good light variation study filter according to claim 10, and the above-mentioned angle θ differs from $\pi/4$.

[Claim 15] The good light variation study filter further equipped with $1/4$ wavelength plate which is a good light variation study filter according to claim 10, and is prepared between the above-mentioned birefringence element and the 2nd polarizer of the above.

[Claim 16] It is the good light variation study filter which it is a good light variation study filter according to claim 1, the above-mentioned Faraday-rotation child consists of the 1st and 2nd Faraday-rotation children, the above-mentioned birefringence element is prepared between the above 1st and the 2nd Faraday-rotation child, and input light passes in order of the 1st polarizer of the above, the Faraday-rotation child of the above 1st, the above-mentioned birefringent plate, the Faraday-rotation child of the above 2nd, and the 2nd polarizer of the above.

[Claim 17] The good light variation study filter which is a good light variation study filter according to claim 16, and was further equipped with a means to control the above 1st and the 2nd Faraday-rotation child so that the Faraday-rotation angle of the Faraday-rotation child of the above 1st and the Faraday-rotation angle of the Faraday-rotation child of the above 2nd become equal substantially.

[Claim 18] It is the good light variation study filter which it is a good light variation study filter according to claim 1, the above-mentioned birefringence element consists of the 1st and 2nd birefringence elements, the above-mentioned Faraday-rotation child is prepared between the above 1st and the 2nd birefringence element, and input light passes in order of the 1st polarizer of the above, the birefringence element of the above 1st, the above-mentioned Faraday-rotation child, the birefringence element of the above 2nd, and the 2nd polarizer of the above.

[Claim 19] It is a good light variation study filter according to claim 18, and the optical axis of the above 1st and the 2nd birefringence element is an parallel good light variation study filter mutually.

[Claim 20] It is the good light variation study filter with which it has further the adjustable phase shift child who is a good light variation study filter according to claim 1, and is prepared between the above 1st and the 2nd polarizer, and input light is supplied to the 1st polarizer of the above.

[Claim 21] a good light variation study filter according to claim 20 — it is — the above-mentioned adjustable phase shift child — the 1st and 2nd $1/4$ wavelength plate — this — a good light variation study filter equipped with another the 1st and 2nd adjustable Faraday-rotation children prepared in a wooden floor $1/4$ wave

[Claim 22] The good light variation study filter according to claim 1 characterized by providing the following. The above-mentioned Faraday-rotation child is a magneto optics crystal arranged on an optical path. A magnetic field impression means to impress to the above-mentioned magneto optics crystal so that it may become larger than the value as which the 1st and 2nd mutually different magnetic fields of a direction were beforehand determined to such synthetic magnetic field strength. A magnetic field adjustment means to change either [at least] the

above 1st or the 2nd magnetic field strength.

[Claim 23] It is the good light variation study filter impressed in the direction which intersects perpendicularly mutually [are a good light variation study filter according to claim 22, and] in a flat surface including the propagation direction of light where the above 1st and the 2nd magnetic field penetrate the above-mentioned magneto optics crystal, respectively.

[Claim 24] The above-mentioned magnetic field adjustment means is a good light variation study filter which adjusts the drive current of the above-mentioned electromagnet including the electromagnet and permanent magnet with which it is a good light variation study filter according to claim 22, and the above-mentioned magnetic field impression means impresses the above 1st and the 2nd magnetic field, respectively.

[Claim 25] The above-mentioned magnetic field adjustment means is a good light variation study filter which adjusts either [at least] the above 1st or the drive current of the 2nd electromagnet including the 1st and 2nd electromagnets with which it is a good light variation study filter according to claim 22, and the above-mentioned magnetic field impression means impresses the above 1st and the 2nd magnetic field, respectively.

[Claim 26] a good light variation study filter according to claim 22 — it is — the account of a top — the good light variation study filter whose magnetization of the above-mentioned magneto optics crystal of the value defined beforehand is a value equivalent to the magnetic field strength needed for being saturated

[Claim 27] the [the 1st which it is a good light variation study filter according to claim 1, and the above 1st and the 2nd polarizer become from the birefringence matter, respectively, and] — from the rust board which goes away two — becoming — this — the [the 1st and] — the rust board which goes away two It is arranged so that the fields which counter and correspond to the bottom and crowning of a rust board which go away two may become parallel mutually. the [this] — the crowning and bottom of a rust board which go away one — respectively — the [this] — with the 1st optical fiber The 1st lens for supplying the light from this 1st optical fiber to the wedge board of the above 1st, The good light variation study filter further equipped with the 2nd lens on which the light from the wedge board of the above 2nd is converged, and the 2nd optical fiber which the light beam which converged with this 2nd lens combines with the bottom of predetermined conditions.

[Claim 28] The good light variation study filter with which it is a good light variation study filter according to claim 27, and it is [each polarization part elongation of the above 1st and the 2nd wedge board] satisfied of $f \sin \theta < a$ when setting the focal distance of a and the 2nd lens of the above to f for the diameter of the core of the 2nd optical fiber of the above, θ and.

[Claim 29] Are a good light variation study filter according to claim 1, and the 1st polarizer of the above consists of the 1st wedge board which consists of birefringence matter. the [the 2nd which the 2nd polarizer of the above becomes from the birefringence matter, respectively, and] — from the rust board which goes away three — becoming — this — the [the 1st or] — the rust board which goes away three It is arranged so that the bottom and crowning of a rust board which go away three may be countered. the [this] — the crowning and bottom of a rust board which go away one — respectively — the [this] — the bottom and crowning of a rust board which go away two — countering — the [this] — the crowning and bottom of a rust board which go away two — respectively — the [this] — with the 1st optical fiber The 1st lens for supplying the light from this 1st optical fiber to the wedge board of the above 1st, The good light variation study filter further equipped with the 2nd lens on which the light from the wedge board of the above 3rd is converged, and the 2nd optical fiber which the light beam which converged with this 2nd lens combines with the bottom of predetermined conditions.

[Claim 30] Are a good light variation study filter according to claim 1, and the above 1st and the 2nd polarizer in the 1st and 2nd monotonous shells which consist of birefringence matter, respectively The 1st optical fiber, The good light variation study filter further equipped with the 1st lens for supplying the light from this 1st optical fiber to the 1st plate of the above, the 2nd lens on which the light of the monotonous shell of the above 2nd is converged, and the 2nd optical fiber which the light beam which converged with this 2nd lens combines with the bottom of predetermined conditions.

[Claim 31] It is a good light variation study filter containing the element which carries out considerable [of each of one filter unit] to the 1st polarizer of the above, the above-mentioned birefringence element, and the above-mentioned Faraday-rotation child, respectively even if it is a good light variation study filter according to claim 1, it has further at least one filter unit prepared between the above 1st and the 2nd polarizer and this ** cannot be found.

[Claim 32] It is the good light variation study filter which is further equipped with the adjustable phase shift child who is a good light variation study filter according to claim 31, and is prepared between the above 1st and the 2nd polarizer, and contains further the element with which the above-mentioned adjustable phase shift child deserves each above-mentioned filter unit.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] Especially this invention relates to the good light variation study filter from which the configuration of a characteristic curve of generally giving the wavelength property of permeability about a good light variation study filter applicable to systems, such as optical fiber communication system, changes to the shaft orientation of permeability.

[0002]

[Description of the Prior Art] recent years — low loss (for example, 0.2dB/(km)) — the manufacturing technology and the used technology of an optical fiber are established, and optical fiber communication system which makes an optical fiber a transmission line is put in practical use. Moreover, in order to compensate the loss in an optical fiber and to enable long-distance transmission, use of the light amplifier for amplifying signal light is proposed or put in practical use.

[0003] The light amplifier known conventionally is equipped with the optical-amplification medium by which the signal light which should be amplified is supplied, and the means which carries out the pumping of the optical-amplification medium so that the gain band where an optical-amplification medium contains the wavelength of signal light may be offered. For example, erbium-doped fiber amplifier (EDFA) is equipped with the pump light source for supplying to EDF the pump light which has the wavelength beforehand determined as the erbium-doped fiber (EDF) as an optical-amplification medium. By using the pump light which has the wavelength of 0.98–micrometer band or 1.48–micrometer band, the gain band containing the wavelength of 1.55 micrometers is obtained. Moreover, the light amplifier using a semiconductor chip as an optical-amplification medium is also known. In this case, a pumping is performed by pouring current into a semiconductor chip.

[0004] On the other hand, there is a wavelength division multiplex (WDM) as technology for increasing the transmission capacity by the optical fiber. In the system by which WDM is applied, two or more optical carriers which have different wavelength are used. The wavelength division multiplex of two or more lightwave signals obtained by modulating each optical carrier independently is carried out by the optical multiplexer, and the WDM signal light obtained as a result is sent out on an optical-fiber-transmission way. In a receiving side, the received WDM signal light is divided into each lightwave signal by the optical demultiplexer, and transmission data are reproduced based on each lightwave signal. Therefore, according to the multiplex number concerned, the transmission capacity by one optical fiber can be increased by applying WDM.

[0005] A transmission distance is restricted by the gain property (wavelength property of gain) often called a gain inclination (gain tilt) when including a light amplifier in the system by which WDM is applied. For example, in EDFA, gain deflection arises in near with a wavelength of 1.55 micrometers. If a gain inclination accumulates about two or more EDFAs by which the cascade connection was carried out, the light SNR (signal-to-noise ratio) of the channel in which gain is included in a small band will become bad.

[0006] A gain equalizer can be used in order to cope with the gain inclination of a light amplifier. Gain identification is performed by the gain equalizer prepared in the position suitable in front rather than degradation of the light SNR of a certain channel becomes superfluous by accumulation of a gain inclination.

[0007] There is a good light variation study filter as an optical device usable as a gain equalizer. In a good light variation study filter, the wavelength property (wavelength dependency of a permeability) of permeability (or loss) is adjustable. For example, the wavelength property of a good light variation study filter is set up or controlled to offset the gain inclination of a light amplifier, and thereby, the deflection between channels of the power of the lightwave signal in a receiving side becomes small.

[0008] The good light variation study filter which has a mechanical movable portion conventionally is known. In this kind of light filter, the degree of incident angle of the light beam to an optical interference film or a diffraction grating is changed mechanically, and, thereby, the main wavelength of a transmitted wave length band and the main wavelength of a prevention wavelength-range region changes, for example. That is, the configuration of a characteristic curve of giving the wavelength property of permeability changes to the shaft orientation of wavelength. Moreover, the good light variation study filter currently offered makes the split beam Fourier filter (Split-Beam Fourier Filter) the basic principle from Photograph NIKUSU Technologies (Photonics Technologies), and not only main wavelength but the amount of prevention (permeability) itself is made adjustable by the mechanical means. That is, the configuration of a characteristic curve of giving the wavelength property of permeability is adjustable not only at the shaft orientation of wavelength but at the shaft orientation of permeability.

[0009] Moreover, the waveguide type Mach TSUENDA (Mach-Zehnder-MZ) light filter, the AKO slope-tunable filter (Acousto-Optic Tunable Filter: AOTF), etc. are known as a good light variation study filter to which does not have a mechanical movable portion and the wavelength property of loss can be changed by the electric means.

[0010] Furthermore, the main wavelength adjustable optical band pass filter which made the birefringent filter the basic principle is proposed (JP 6-130339A).

[0011]

[Problem(s) to be Solved by the Invention] It has the fault that high-speed operation is difficult for the good light variation study filter which has mechanical moving part, and it lacks in reliability. Moreover, (3) temperature stabilizer with (2) power consumption large now with high (1) driver voltage is required for MZ light filter or AOTF, and they have the fault of ** from which (4) reliability which cannot avoid large-scale-ization is not acquired.

[0012] For this reason, (1) (3) driver voltage it can control [that do not have mechanical moving part, therefore high reliability is acquired and] by (2) electric means are low, and the good light variation study filter which fulfills conditions, like power consumption is small is demanded.

[0013] As a candidate of the good light variation study filter which fulfills these conditions, the good light variation study filter indicated by JP 6-130339A is mentioned. It has the adjustable Faraday-rotation child who gives a strange Faraday-rotation angle with this good light variation study filter, and is made for the configuration of a characteristic curve of giving the wavelength property of permeability to change to the shaft orientation of wavelength according to change of a Faraday-rotation angle. However, the configuration of a characteristic curve cannot change to the shaft orientation of permeability. For the use of a gain equalizer mentioned above, since it is required that the loss depth of a prevention wavelength-range region should be adjustable, for example, this good light variation study filter cannot necessarily say it with having sufficient performance as a gain equalizer.

[0014] Therefore, the purpose of this invention is to offer a good light variation study filter from which the configuration of a characteristic curve of giving the wavelength property of permeability changes to the shaft orientation of permeability. Other purposes of this invention become clear from the following explanation.

[0015]

[Means for Solving the Problem] According to the side with this invention, the good light

variation study filter equipped with the 1st and 2nd polarizers, the birefringence element, and the Faraday-rotation child is offered. Each of the 1st and 2nd polarizers has the transparency shaft which determines the polarization shaft of the polarization to penetrate. A birefringence element is prepared between the 1st and 2nd polarizers, and gives phase contrast between the rectangular cross 2 polarization components to penetrate. Phase contrast is determined by the optical axis of a birefringence element. A Faraday-rotation child is prepared between the 1st and 2nd polarizers, and gives an adjustable Faraday-rotation angle to the polarization to penetrate. The relative location of the array sequence of a birefringence element and a Faraday-rotation child and each transparency shaft of the optical axis of a birefringence element, the 1st, and 2nd polarizers is set up so that the configuration of a characteristic curve of giving the wavelength property of permeability may change to the shaft orientation of permeability according to change of a Faraday-rotation angle.

[0016] According to this composition, since array sequence and relative location are set as the specific form, the configuration of a characteristic curve becomes adjustable to the shaft orientation of permeability, for example, the loss depth of a prevention wavelength-range region can be changed now, and one of the purposes of this invention is attained.

[0017] In addition, “permeability” is defined by this application specification as power permeability.

[0018] [Embodiments of the Invention] Hereafter, with reference to an accompanying drawing, the form of desirable operation of this invention is explained in detail. First, since it is thought that it is useful when you understand the composition and operation of a good light variation study filter by this invention, a birefringent filter is explained with reference to drawing 1. A birefringent filter arranges the 1st polarizer P1, a birefringent plate BP, and the 2nd polarizer P2 on the optical path OP of the transmitted light at this order, and is constituted. Here, the rectangular three-dimensions system of coordinates (X, Y, Z) which have the Z-axis parallel to an optical path OP are adopted. Here, the X-axis and the Y-axis are parallel to the optical axis (C1 shaft and C2 shaft) of a birefringent plate BP respectively, and the angle which the transparency shaft and the Y-axis of the 1st polarizer P1 make presupposes that it is 45 degrees. The angle which the 2nd transparency shaft and Y-axis of a polarizer P2 make is arbitrary. In addition, "the transparency shaft of a polarizer" is defined as a shaft which more generally determines the polarization shaft of the polarization which penetrates the polarizer in accordance with the oscillating direction of the linearly polarized light to penetrate.

[0019] If the linearly polarized light which penetrated the 1st polarizer P1 carries out incidence to a birefringent plate BP, it will separate into the component which has plane of polarization parallel to C1 shaft, and the component which has plane of polarization parallel to C2 shaft, and this linearly polarized light will spread the interior of a birefringent plate BP. These two components are compounded under the phase contrast determined according to wavelength, when outputted from a birefringent plate BP. The polarization states of the light compounded [λ / the output of a birefringent plate BP / when sufficiently large / compared with the wavelength of an incident light / in the thickness of a birefringent plate BP] differ according to wavelength. That is, it may be found with wavelength whether it is the linearly polarized light, or the compounded light may be the circular polarization of light or elliptically polarized light. The permeability of the 2nd polarizer P2 changes with wavelength, in order to be dependent on the polarization state of the light which carries out incidence to the 2nd polarizer P2. For example, supposing it is fixed so that it may become parallel to the linearly polarized light of wavelength with the transparency shaft of the 2nd polarizer P2, the permeability of the 2nd polarizer P2 to the light of the wavelength will become 100% theoretically. In different wavelength from this, the permeability of the 2nd polarizer P2 becomes 0% theoretically to the linearly polarized light which intersects perpendicularly with the transparency shaft of the 2nd polarizer P2. Furthermore, the permeability of the 2nd polarizer P2 to the circular polarization of light of other wavelength is 50% theoretically, and the permeability of the 2nd polarizer P2 to the elliptically polarized light of another wavelength becomes a thing according to the ovality of elliptically polarized light. Thus, the permeability of this birefringent filter will change depending on the wavelength of light.

[0020] (A) of drawing 2 and (B) are drawings for explaining the example of the property of the conventional good light variation study filter. For example, with the good light variation study filter indicated by JP.6-130339A, it replaces with the birefringent plate BP of the birefringent filter of drawing 1, the phase shift child containing a Faraday-rotation child and two 1/4 wavelength plates is prepared, and the wavelength property that permeability changes periodically to wavelength by this is acquired. The configuration of a characteristic curve of giving this wavelength property is adjustable at the shaft orientation of wavelength, as shown to (A) of drawing 2 by a solid line and the dashed line.

[0021] Therefore, by using this good light variation study filter, as shown in (B) of drawing 2, the configuration of a characteristic curve can provide the shaft orientation of wavelength with the optical band pass filter which is adjustable.

[0022] (A) of drawing 3 and (B) are drawings for explaining the example of the property of a good light variation study filter demanded of this invention. (A) of drawing 2 requires the good light variation study filter whose configuration of a characteristic curve is adjustable at the shaft orientation of permeability, as the configuration of a characteristic curve is shown in the shaft orientation of wavelength to being adjustable at (A) of drawing 3. Specifically, in consideration of the use as a gain equalizer, as shown in (B) of drawing 3, realization of the notch filter whose loss depth in a prevention wavelength-range region is adjustable is demanded.

[0023] Next, after performing quantitative analysis about the birefringent filter of drawing 1, this is developed, and the method for offering the good light variation study filter which has a property as shown in (A) of drawing 3 and (B) is shown. Now, in the birefringent filter of drawing 1, transparency shaft P1A of the 1st polarizer P1, the optical axis (C1 shaft and C biaxial) of a birefringent plate BP, and transparency shaft P2A of the 2nd polarizer P2 assume that it is in physical relationship as shown in drawing 4. That is, the angle which transparency shaft P1A and C biaxial make is set to phi, and the angle which transparency shaft P2A and C biaxial make is set to theta.

[0024] In parallel with transparency shaft P1A, the component E1 parallel to C1 shaft, of the light which passed the birefringent plate BP when the linearly polarized light sin (omegat) carries out incidence, and the component E2 parallel to C biaxial are E1=sinphisin (omega t+epsilon1), respectively, when phase lag of both components is set to epsilon1 and epsilon2, respectively. E2=cosphisin (omega t+epsilon2)

It can write, amplitude of the light which came out of the 2nd polarizer P2 $E_1 \sin \theta + E_2 \cos \theta = \sin \phi \sin \theta + (\omega \epsilon - \sin^2 \phi) \cos \theta$. It becomes, therefore, the intensity I of the transmitted light is $I = \cos^2(\phi + \theta)$. If the refractive-index difference of an ordinary ray [in d and a birefringent plate BP / for the thickness of a birefringent plate BP] and an extraordinary ray is set to mu and wavelength is set to lambda, it will become $(\epsilon - \epsilon') / 2 = \mu / \lambda$. Therefore the intensity I of the transmitted light serves as the function f of wavelength lambda $I(\lambda) = \cos^2(\phi + \theta) \sin^2(2\phi) \sin^2(2\theta) \cos^2(\mu / \lambda)$ (1) It can express. (1) A formula shows transmitted light intensity having a wavelength dependency and changing periodically to wavelength. Here, if the value of wavelength is large compared with the actually used wavelength-range region, μ / λ can be approximated by the linear function as follows.

[0025] It will be set to $a = 4.165 \times 10^{-7}$ (1/nm2) and $b = 1.291 \times 10^{-3}$ (1/-nm) if a wavelength-range region is set to 1500nm - 1600nm so that it may be shown in 1 / lambda da = a lambda + b, for example, drawing 5 .

[0026] Therefore, when b is disregarded and only relative wavelength is considered, it is, 1
 $(\lambda) = \cos^2(\phi + \theta) + \sin^2(2\phi) \sin^2(\theta) \cos^2(\phi \lambda_{\text{band}} / \text{FSR}) \dots (1)$ is obtained. Here,
 it is FSR (Free Spectral Range). The wavelength period in the wavelength property of
 permeability is expressed, and it is given by the following formula.

[0027] $FSR=1/\Delta\mu d$ (2)

determined by the material of a birefringent plate BP is fixed, it turns out that what is necessary is just to adjust thickness d of a birefringent plate BP.

[0028] Now, (1) formula shows that transmitted light intensity also changes, when angle ϕ and/or angle θ are changed. If drawing 6 is referred to, angle ϕ is made into $\pi/4$ (45 degrees), and the situation of change of the wavelength property of the permeability when changing the value of angle θ is shown, for example. A vertical axis is permeability (true value) and a horizontal axis is the relative wavelength standardized by FSR. Moreover, there are a positive value and a negative value as a value of angle θ , because the relative hand of cut between C biaxial and transparency shaft P2A is shown, and it is explained in detail about this later.

[0029] The direct method of changing angle θ is rotating transparency shaft P2A of the 2nd polarizer P2. There is no polarizer which a transparency shaft can rotate with the present technology, without using mechanical means. Moreover, although the polarizer turning around a transparency shaft can be offered if a mechanical means is used, the good light variation study filter which has mechanical moving part is difficult high-speed operation, and it has problems, like reliability is missing again. Then, in this invention, the method using an adjustable Faraday-rotation child is proposed so that it may explain in detail below.

[0030] It can also be said that transparency shaft P2A of the 2nd polarizer P2 is C biaxial and the angle to make, and angle θ is an angle which the polarization shaft of light and transparency shaft P2A of the 2nd polarizer P2 by which incidence is carried out to the 2nd polarizer P2 make. That is, "rotating transparency shaft P2A of the 2nd polarizer P2" is substantially [as "rotating the polarization shaft of the light by which incidence is carried out to the 2nd polarizer P2"] the same. Therefore, the Faraday-rotation child who gives an adjustable Faraday-rotation angle can be stationed between a birefringent plate BP and the 2nd polarizer P2, the state same if the azimuth of the polarization by which incidence is carried out to the 2nd polarizer P2 is rotated can be realized, and it is as possible as angle θ changed to change transmitted light intensity according to the rotation.

[0031] Moreover, similarly, an adjustable Faraday-rotation child can be stationed between the 1st polarizer P1 and a birefringent plate BP, the state same if the azimuth of the polarization by which incidence is carried out to a birefringent plate BP is rotated can be realized, and it is as possible as angle ϕ changed to change transmitted light intensity according to the rotation. [0032] The [of the good light variation study filter according to this invention respectively if (A) of drawing 7 and (B) are referred to / the 1st and] -- 2 operation forms are shown With the 1st operation form shown in (A) of drawing 7, the adjustable Faraday-rotation child FR is formed between a birefringent plate BP and the 2nd polarizer P2, and the adjustable Faraday-rotation child FR is formed between the 1st polarizer P1 and the birefringent plate BP with the 2nd operation form shown in (B) of drawing 7.

[0033] here -- the [the 1st and] -- in each of 2 operation forms, the simplest and clear requirements for carrying out the good light variation study filter by this invention are reconfirmed With each operation form, a birefringent plate BP and the adjustable Faraday-rotation child FR are formed between the 1st polarizer P1 and the 2nd polarizer P2. The 1st polarizer P1 has transparency shaft P1A which determines the polarization shaft of the polarization to penetrate, and the 2nd polarizer P2 has transparency shaft P2A which determines the polarization shaft of the polarization to penetrate. The birefringent plate BP has the optical axis (C1 shaft and C biaxial, or its either) which determines the phase contrast given between the rectangular cross 2 polarization components to penetrate. The adjustable Faraday-rotation child FR gives an adjustable Faraday-rotation angle to the polarization to penetrate. And the relative location of array sequence [of a birefringent plate BP and the adjustable Faraday-rotation child FR], optical-axis (for example, C1 shaft), and transparency shaft P1A and P2A is set up so that the configuration of a characteristic curve of giving the wavelength property of permeability may change to the shaft orientation of permeability according to change of a Faraday-rotation angle.

[0034] Moreover, the thickness of a birefringent plate BP is designed so that necessary FSR may be obtained. In order to realize the wavelength dependency of permeability, the birefringent

plate which has thickness thick [as a birefringent plate BP / compared with the birefringent plate called 1/4 wavelength plate and 1/2 wavelength plate] and sufficiently larger than the wavelength specifically used is used. Furthermore, the birefringent plate which can specifically give the phase contrast equivalent to 20 waves or 100 waves is adopted.

[0035] With the 1st operation form shown in (A) of drawing 7, input light passes the 1st polarizer P1, a birefringent plate BP, the adjustable Faraday-rotation child FR, and the 2nd polarizer P2 in this order along with an optical path OP.

[0036] With the 2nd operation gestalt shown in (B) of drawing 7, input light passes the 1st polarizer P1, the adjustable Faraday-rotation child FR, a birefringent plate BP, and the 2nd polarizer P2 in this order along with an optical path OP.

[0037] the member in each operation gestalt of the good light variation study filter according [drawing 8] to this invention -- it is drawing showing the physical relationship of a between Here, in rectangular three-dimensions system of coordinates (X, Y, Z), the Z-axis presupposes that it is parallel to an optical path OP, and makes a Y-axis parallel to transparency shaft P1A of the 1st polarizer P1. Moreover, ϕ , θ , and δ are newly defined as follows still more clearly.

[0038] ϕ : The angle which C1 shaft of a birefringent plate BP and transparency shaft P1A (Y-axis) of the 1st polarizer P1 make. A sign makes positive the angle used as right-handed rotation, when rotating toward C1 shaft from a Y-axis.

[0039] θ : The angle which C1 shaft of a birefringent plate BP and transparency shaft P2A of the 2nd polarizer P2 make. A sign makes positive the angle used as right-handed rotation, when rotating toward C1 shaft from transparency shaft P2A.

[0040] δ : The angle which transparency shaft P1A (Y-axis) of the 1st polarizer P1 and transparency shaft P2A of the 2nd polarizer P2 make. A sign makes positive the angle used as right-handed rotation, when rotating toward transparency shaft P2A from a Y-axis.

[0041] Therefore, it becomes $\phi = \theta + \delta$. Moreover, the sign of the Faraday-rotation angle α given by the Faraday-rotation child FR makes positive the angle used as left-handed rotation, when rotating toward a Y-axis from the X-axis.

[0042] In addition, in drawing 8, the group of the ellipse (a circle is included) and straight line which are expressed with Sign PS expresses the wavelength dependency of the polarization state in the output of the birefringent plate BP when presupposing that it is $\alpha = 0$.

[0043] In order to give a wavelength dependency to the transmitted light intensity of a good light variation study filter, it is necessary to avoid the conditions " $\sin(2\phi) \sin(2\theta)$ is always 0" so that clearly from (1) formula. For this reason, it is referred to as $\phi = n\pi/2$ (n is an integer) in offering the same state as having changed angle θ substantially using the Faraday-rotation child FR like the 1st operation gestalt shown in (A) of drawing 7. Moreover, it is referred to as $\theta = m\pi/2$ (m is an integer) in offering the state same like the 2nd operation gestalt shown in (B) of drawing 7 as having changed angle ϕ substantially using the Faraday-rotation child FR.

[0044] According to the optical theory, the operation which the polarization state and light-copulsed child of light exert on the passage light is expressed by the Jones matrix (Jones Matrix) expressed with the Jones vector (Jones Vector) and 2x2 matrices which are expressed with 1x2 matrices. Moreover, the photoelectrical force in each shunt is expressed with the sum of squares of two components of Jones vector. The permeability (power permeability) of the good light variation study filter by this invention is calculable with the matrix calculation using Jones vector and the Jones matrix.

[0045] Drawing 9 expresses the result which calculated the wavelength property of the permeability in the 1st operation gestalt shown in (A) of drawing 7. Here, it is referred to as $\phi = \pi/4$, and $\delta = 0$, and the Faraday-rotation angle α is changed. The relative wavelength by which the vertical axis was standardized with permeability (dB) and the horizontal axis was standardized by FSR is expressed. It is clear for the configuration of a characteristic curve of giving a wavelength property to make a fix point the point that relative wavelength is 0.25 and -0.25 here, and to change in the direction of the shaft (vertical axis) of permeability according to the Faraday-rotation angle α .

[0046] When referred to as $\phi = \pi/4$, it is the range of $-\delta < \alpha < \pi/2$ (of ranges).

or when referred to as $\phi = \pi/4$, all the states where the Faraday-rotation angle α is changed in the range ($\pi/2$ of ranges) of $-\Delta\alpha > \pi/2 - \Delta$, and π and the wavelength property of permeability can take can be realized.

[0047] moreover, the sign of the Faraday-rotation angle α which will be changed by this relation if $\Delta = 0$, i.e., transparency shaft P1A, and P2A are mutually made parallel -- positive/negative -- it turns out that only either should be chosen. Therefore, by being referred to as $\Delta = 0$, it is set to $0 < \alpha < \pi/2$, or $0 > \alpha > -\pi/2$, the adjustable Faraday-rotation child who, on the other hand, gives the Faraday-rotation angle α only to π can be used now, and the Faraday-rotation child's FR composition can be simplified. This is the same also in the operation gestalt shown in (B) of drawing 7.

[0048] If the adjustable Faraday-rotation child who can give the Faraday-rotation angle α to both directions is used contrary to this, by setting up with $\Delta = \pi$, at the time of $\alpha = 0$, permeability will not be based on wavelength but will become fixed. For example, when the good light variation study filter by this invention is built into a system, and control OFF comes and it is set to $\alpha = 0$, permeability may not be based on wavelength but it may be desirable that it is fixed. Moreover, since it is set to $-\pi/4 < \alpha < \pi/4$ at this time, the absolute value of the Faraday-rotation angle α becomes smaller than $\pi/4$, and when the adjustable Faraday-rotation child adapting the magneto-optical effect etc. is used, it becomes possible to reduce power consumption when having set the Faraday-rotation angle α as maximum. What is necessary is to realize the same argument also in the 2nd operation gestalt shown in (B) of drawing 7, and just to consider as $\Delta = \theta$ in that case.

[0049] The good light variation study filter which has a property like drawing 9 can consider the application as a power equalizer for example, whose loss inclination is adjustable. Here, a "loss inclination" points out the inclination, when the characteristic curve which gives the wavelength property of the permeability when expressing permeability with an opposite numeral is linear, as shown in drawing 10. In for example, optical fiber communication system, the power equalizer whose loss inclination is adjustable is effective, when the gain inclination of a light amplifier is equalized, or when compensating the loss inclination of an optical fiber.

[0050] When a loss inclination uses the good light variation study filter which has the property shown in drawing 9 as an equalizer which is adjustable, it becomes possible by, for example, choosing a use wavelength-range region as follows to keep constant the average (for "average dissipation" to be called hereafter) of loss of the area within a wavelength range. That is, the central value of two wavelength which adjoins each other among some wavelength from which the maximum loss or the minimum loss is acquired is chosen as the main wavelength of a use wavelength-range region, and the bandwidth of a use wavelength-range region is set up smaller than one half of FSR(s).

[0051] Drawing 11 is the example which made C points which give the central value of A points and B points from which the maximum loss or the minimum loss is respectively acquired in the graph shown in drawing 9 the main wavelength of a use wavelength-range region, and chose one fifth of FSR(s) as a use wavelength-range region. It turns out that the property that a loss inclination is adjustable is acquired. Moreover, in this example, even if it changes the Faraday-rotation angle α , it turns out that average dissipation does not change. In addition, in the graph of drawing 11, in order to show clearly that each characteristic curve is linear, the perfect straight line is shown by the dashed line (also setting to drawing 13 and 16 the same).

[0052] However, with the good light variation study filter which has the property of drawing 11, the big value and big bird clapper of 3dB in average dissipation are a fault. In order to solve this problem, the following two methods can be considered.

[0053] First, the 1st method is a method of changing the angle (ϕ or θ) which either transparency shaft P1A and P2A and C1 shaft of a birefringent plate BP make with $\pi/4$. For example, in the 1st operation form shown in (A) of drawing 7, angle ϕ is set up so that $0 < \phi < \pi/4$ may be filled, and angle ϕ is set up so that the Faraday-rotation angle α may be changed in the range of $-\Delta\alpha > \pi/2 - \Delta$ or $-\pi/4 < \phi < \pi/4$ may be filled, and the Faraday-rotation angle α is changed in the range of $-\Delta\alpha > \pi/2 - \Delta$.

[0054] Each of (A) of drawing 12 and (B) is the result of calculating the wavelength property of

permeability, being referred to as $\phi = \pi/6$, and $\Delta = 0$, and changing the Faraday-rotation angle α . Moreover, drawing 13 shows the wavelength property which expanded the wavelength property shown in each of (A) of drawing 12, and (B) according to the range of the relative wavelength in drawing 11, and was acquired.

[0055] It turns out that average dissipation is small as compared with the wavelength property shown in drawing 11 so that clearly from drawing 13. However, in the example of drawing 13, average dissipation will change according to change of the Faraday-rotation angle α .

[0056] In the 2nd operation form shown in (B) of drawing 7 [whether θ is set up so that $0 < \theta < \pi/4$ may be filled, and the Faraday-rotation angle α is changed in the range of $-\Delta\alpha > \pi/2 - \Delta$, and] Or the effect same in the 1st operation form of (A) of drawing 7 is acquired by setting up θ so that $-\pi/4 < \theta < \pi/4$ may be filled, and changing the Faraday-rotation angle α in the range of $-\Delta\alpha < -\pi/2 - \Delta$.

[0057] In addition, when it sets up so that angle ϕ or angle θ may be differed from $\pi/4$ by the 1st method, the adjustable Faraday-rotation child who, on the other hand, gives the Faraday-rotation angle α only to π can be used by considering as angle $\Delta = 0$, moreover, the thing considered as $\Delta = \theta$ in the 1st operation form shown in (A) of drawing 7 -- moreover, by considering as $\Delta = \theta$ in the 2nd operation form shown in (B) of drawing 7, when set to $\alpha = 0$ as control OFF, the effect that permeability is not based on wavelength but becomes fixed is acquired.

[0058] The effect acquired by changing angle ϕ or angle θ with $\pi/4$ that it is realizable also by inserting $1/4$ wavelength plate at the suitable angle for a suitable position, and shifting a polarization direction is clear as shown in each of (A) of drawing 14, and (B).

[0059] The 3rd operation form of the good light variation study filter by this invention shown in (A) of drawing 14 is characterized as contrasted with the 1st operation form shown in (A) of drawing 7 in that $1/4$ wavelength plate 2 is additionally formed between the 1st polarizer P1 and the birefringent plate BP.

[0060] The 4th operation form of the good light variation study filter by this invention shown in (B) of drawing 14 is characterized as contrasted with the 2nd operation form shown in (B) of drawing 7 in that $1/4$ wavelength-plate 2' is additionally prepared between a birefringent plate BP and the 2nd polarizer P2.

[0061] The 2nd method is a method of using a partially polarized light child as the 2nd polarizer P2. Here, a "partially polarized light child" points out the polarizer in which a certain value whose permeability is not 0 (anti-logarithm) is shown to the incidence of the linearly polarized light which has the plane of polarization which intersects perpendicularly with a transparency shaft. In a partially polarized light child, the permeability of the linearly polarized light which has the plane of polarization which intersects perpendicularly with a transparency shaft is defined as t. [0062] Drawing 15 shows the result which calculated the wavelength property of permeability as $\phi = \pi/4$, and $\Delta = 0$, changing the Faraday-rotation angle α , using the partially polarized light child of $t = 0.25$ (-6dB) as the 2nd polarizer P2. Moreover, drawing 16 shows the wavelength property which expanded a part of wavelength property shown in drawing 15, and was acquired. As compared with the property shown in drawing 11, average dissipation is small about the property shown in drawing 16, and it is clear that average dissipation moreover is not changing to change of the Faraday-rotation angle α .

[0063] When enforcing the 2nd method in the 1st operation form shown in (A) of drawing 7, a good variate (the adjustable range of the permeability in a certain wavelength) can be made into the maximum by setting it as $\phi = \pi/4$. It is because all the states where the wavelength property of permeability can take are realizable as mentioned above. Moreover, when enforcing the 2nd method in the 2nd operation form shown in (B) of drawing 7, similarly a good variate can be made into the maximum by setting it as $\theta = \pi/4$. When enforcing the 2nd method, the adjustable Faraday-rotation child who, on the other hand, gives the Faraday-rotation angle α to π can be used by being referred to as $\Delta = 0$, moreover, the thing considered as $\Delta = \theta$ in the 1st operation form shown in (A) of drawing 7 -- moreover, by considering as $\Delta = \theta$ in the 2nd operation form shown in (B) of drawing 7, when set to $\alpha = 0$ as control OFF, the effect that permeability is not based on wavelength but becomes fixed is acquired.

[0064] The 1st and 2nd methods are effective in order to give a limited value to the maximum loss. For example, since power permeability can take the value of 0 (anti-logarithm) theoretically when referred to as $\phi i = \pi/4$ in the 1st operation form shown in (A) of drawing 7, the maximum loss (dB) becomes infinite so that clearly from drawing 9, such a property may not be desirable on systems operation. Then, it becomes possible by using the 1st or 2nd method to suppress the maximum loss (dB) to a limited value. This is clear from (A), (B), and drawing 15 of drawing 12.

[0065] Drawing 17 is drawing showing the 5th operation form of the good light variation study filter by this invention. This operation form is characterized as contrasted with one adjustable Faraday-rotation child FR being used in the operation form explained until now in that two adjustable Faraday-rotation children FR1 and FR2 are formed between the 1st polarizer P1 and the 2nd polarizer P2. A birefringent plate BP is formed among the Faraday-rotation children FR1 and FR2.

[0066] A different wavelength property from the wavelength property it was explained that it was based on this composition until now can be acquired. For example, Faraday-rotation angle α which sets to $\phi i = \pi/4$ and $\delta = \pi/2$ (n is an integer), and is given by the Faraday-rotation child FR1 Faraday-rotation angle α 2 given by the Faraday-rotation child FR2 $\alpha 1 = \alpha$ 2. The case where it is made to rotate is considered maintaining.

[0067] Input light passes the 1st polarizer P1, the Faraday-rotation child FR1, a birefringent plate BP, the Faraday-rotation child FR2, and the 2nd polarizer P2 in this order along with an optical path OP.

[0068] Drawing 18 sets to $\phi i = \pi/4$, and $\delta = 0$, and the wavelength property of the permeability at the time of rotating the Faraday-rotation angle α (alpha 1 and alpha 2) in $0 < \alpha < \pi/4$ is shown. Here, the partially polarized light child is used as the 2nd polarizer P2.

[0069] The property that the minimum loss in the wavelength property of permeability is not based on the Faraday-rotation angle α , but is always set to 0 is acquired so that clearly from drawing 18. Thus, $\alpha 1 = \alpha 2$ in order to change each Faraday-rotation angle, maintaining the control unit 4 is connected to the Faraday-rotation children FR1 and FR2 with the 5th operation form of drawing 17. A control unit 4 is the Faraday-rotation angle α 1 given by the Faraday-rotation child FR1, Faraday-rotation child α 2 given by the Faraday-rotation child FR2. The Faraday-rotation children FR1 and FR2 are controlled to become equal substantially.

[0070] Drawing 19 is drawing showing the 6th operation form of the good light variation study filter by this invention. This operation form is characterized with an old operation form as contrasted with one birefringent plate BP being used in that two birefringent plates BP1 and BP2 are formed between the 1st polarizer P1 and the 2nd polarizer P2.

[0071] The adjustable Faraday-rotation child FR is formed among birefringent plates BP1 and BP2. Input light passes the 1st polarizer P1, a birefringent plate BP1, the Faraday-rotation child FR, a birefringent plate BP2, and the 2nd polarizer P2 in this order along with an optical path OP.

[0072] Thus, by using two birefringent plates BP1 and BP2, the wavelength property similar to the wavelength property shown in drawing 18 can be acquired. For example, angle ϕi 1 defined like the above-mentioned angle ϕi about the optical axis of birefringent plates BP1 and BP2, respectively. And angle ϕi 2 is made equal ($\phi i 1 = \phi i 2$) and is referred to as $\phi i 1 = \pi/4$, $\phi i 2 = \pi/4$, and $\delta = \pi/2$ (n is an integer).

[0073] Drawing 20 sets to $\phi i = \pi/4$, and $\delta = 0$, and the wavelength property of the permeability at the time of rotating the Faraday-rotation child's FR angle of rotation α in $0 < \alpha < \pi/2$ is shown. Here, the partially polarized light child is used as the 2nd polarizer P2.

[0074] the wavelength property that the minimum loss in the wavelength property of permeability is not based on the Faraday-rotation angle α , but is always set to 0 so that clearly from drawing 20, or profit ***** Moreover, also in the 6th operation form of drawing 19, the Faraday-rotation child who, on the other hand, gives the adjustable Faraday-rotation angle α to ** can be used now by being referred to as $\delta = 0$.

[0075] Drawing 21 is drawing showing the 7th operation form of the good light variation study filter by this invention. The adjustable phase shift child 6 prepared between the 1st polarizer P1 and the 2nd polarizer P2 is characterized by having additionally by this operation form. The

adjustable phase shift child 6 gives phase contrast (retardation) between the polarization components which intersect perpendicularly with a polarization component and it parallel to the optical axis, and the phase contrast is adjustable by the control signal supplied to the adjustable phase shift child 6.

[0076] The 1st polarizer P1, a birefringent plate BP, the adjustable Faraday-rotation child FR, and the 2nd polarizer P2 are arranged according to the 1st operation form shown in (A) of drawing 7, and the adjustable phase shift child 6 is formed between the 1st polarizer P1 and the birefringent plate BP here.

[0077] It not only changes to the shaft orientation of permeability, but according to the operation form of drawing 21, according to change of the Faraday-rotation angle to which the configuration of a characteristic curve of giving the wavelength property of permeability is given by the adjustable Faraday-rotation child FR, the configuration of a characteristic curve comes to change to the shaft orientation of wavelength according to change of the phase contrast given by the adjustable phase shift child 6. Therefore, not only the property of the good light variation study filter explained by (A) of drawing 3 and (B) but the property of the good light variation study filter explained by (A) of drawing 2 and (B) will be acquired.

[0078] In order to change the configuration of a characteristic curve to the shaft orientation of wavelength most effectively, it is desirable for the angle of the adjustable phase shift child's 6 optical axis and the optical axis of a birefringent plate BP to make to be $\pi/2$ (for n to be an integer).

[0079] as the adjustable phase shift child 6 — LiNbO3 etc. — the thing adapting the electro-optical effect is employable. However, generally the variable-phase child adapting the electro-optical effect needs high driver voltage.

[0080] Drawing 22 is drawing showing the 8th operation form of the good light variation study filter by this invention. With this operation form, the adjustable phase shift child's 6 of specific composition is employed, and reduction of the adjustable phase shift child's 6 driver voltage is aimed at.

[0081] The adjustable phase shift child 6 has 1/4 wavelength plates 10 and 12 of two sheets, and another adjustable Faraday-rotation child 8 prepared between 1/4 wavelength plate 10 and 12. The angle of the optical axis of 1/4 wavelength plate 10 and the optical axis of 1/4 wavelength plate 12 to make is set as $\pi/2$.

[0082] By setting the angle of each optical axis of 1/4 wavelength plates 10 and 12, and the optical axis of a birefringent plate BP to make as $\pi/2$ (n being an integer), it comes to change to the shaft orientation of wavelength according to change of the Faraday-rotation angle to which the configuration of a characteristic curve of giving the wavelength property of the permeability of this good light variation study filter is given by the adjustable Faraday-rotation child 8.

[0083] In addition, when the Faraday-rotation angle given by the Faraday-rotation child 8 is β , the phase contrast given by the adjustable phase shift child 6 between rectangular cross 2 polarization components is set to 2β . This principle — the contents of an indication and common knowledge technology of JP.6-130339.A — obvious — it is — since — the explanation is omitted.

[0084] Drawing 23 is drawing showing the 9th operation form of the good light variation study filter by this invention. This operation form is characterized as contrasted with the 8th operation form of drawing 22 in that at least one filter unit is additionally prepared between the 1st polarizer P1 and the 2nd polarizer P2.

[0085] Here, the filter unit 14 (#1, ..., #N) of N (integer with larger N than 1) base is formed. The filter unit 14 (#i) of eye i (integer with which i fills $1 \leq i \leq N$) watch contains the 1st polarizer P1, adjustable phase shift child 6, birefringent plate BP, and polarizer P1 (#i) corresponding to the adjustable Faraday-rotation child FR, adjustable phase shift child 6 (#i), birefringent plate BP (#i), and Faraday-rotation child FR (#i), respectively.

[0086] Since the wavelength property of the permeability as this whole good light variation study filter is given by the sum of the wavelength property of the permeability of the good light variation study filter shown in drawing 22, and the wavelength property of each permeability of a

filter unit 14 (#1, --, #N), it becomes easy to set up the wavelength property of permeability arbitrarily.

[0087] For example, since the wavelength property of the permeability as the whole is given by the sum of three characteristic curves when three characteristic curves which give the wavelength property of permeability respectively in the good light variation study filter of drawing 23 are acquired, as shown in (A) of drawing 24, the wavelength property of desired permeability as shown in (B) of drawing 24 can be acquired.

[0088] Although [here / each filter unit 14 (#i)] it has the adjustable phase shift child 6 (#i) for changing a characteristic curve to the shaft orientation of wavelength, and the birefringent plate BP (#i) and the Faraday-rotation child FR (#1) for changing a characteristic curve to the shaft orientation of permeability. You may make it omit the adjustable phase shift child 6 (#i) or a birefringent plate BP (#i), and the Faraday-rotation child FR (#i) if needed.

[0089] Next, the example of concrete composition of the Faraday-rotation child for giving an adjustable Faraday-rotation angle is explained. It is in the state which generally impressed the magnetic field (magnetic field) in a magneto optics crystal, that is, in the state which set the magneto optics crystal in a certain magnetic field, for example, whenever the linearly polarized light passes through the inside of a magneto optics crystal, the polarization direction (direction given by the projection to a flat surface perpendicular to the propagation direction concerned of the flat surface containing the electric field vector of the linearly polarized light) is rotated in the fixed direction irrespective of the propagation direction of the linearly polarized light.

[0090] This phenomenon is called Faraday rotation and it depends for the size (Faraday-rotation angle) of the angle of rotation of the polarization direction on the direction and strength of magnetization which were produced by the impression magnetic field. [a magneto optics crystal] Specifically, a Faraday-rotation angle is determined by the size of the component of the propagation direction of the light of the intensity of magnetization of a magneto optics crystal.

[0091] Therefore, if a Faraday-rotation child is constituted from a means to impress a magnetic field in the same direction as the propagation direction of light to a magneto optics crystal and this magneto optics crystal and it will glance, the Faraday-rotation angle is effectively adjusted by adjusting an impression magnetic field.

[0092] However, the point which should be taken into consideration here is that the intensity of magnetization of the magneto optics crystal by the impression magnetic field does not reach a saturation state, but many magnetic domains exist in a magneto optics crystal, when the size of an impression magnetic field is comparatively small.

[0093] Such existence of many magnetic domains makes adjustable [**** / a Faraday-rotation angle] difficult, though the repeatability of a Faraday-rotation angle is worsened and good repeatability is secured. Moreover, when many magnetic domains are in a magneto optics crystal, attenuation by dispersion of the light in the interface between each magnetic domain is also produced, and it becomes inconvenient [on practical use].

[0094] With the desirable operation form of this invention, then, an adjustable Faraday-rotation child The magneto optics crystal arranged on an optical path, A magnetic field impression means to impress to a magneto optics crystal so that it may become larger than the value (for example, a value equivalent to the magnetic field strength needed for the intensity of magnetization of a magneto optics crystal being saturated) as which the 1st and 2nd mutually different magnetic fields of a direction were beforehand determined to such synthetic magnetic field strength. A magnetic field adjustment means to change at least one side of the strength of the 1st and 2nd magnetic fields is included.

[0095] In addition, a magnetic domain can understand the state where intensity of magnetization was saturated in the magneto optics crystal, as a state set to one. Desirably, the 1st and 2nd magnetic fields are impressed in the direction which intersects perpendicularly mutually in a flat surface including the propagation direction of the light which penetrates a magneto optics crystal, respectively.

[0096] Drawing 25 is drawing showing the adjustable Faraday-rotation child's 32 example of 1 composition applicable to this invention. The adjustable Faraday-rotation child 32 can use as the adjustable Faraday-rotation child FR or an adjustable Faraday-rotation child 8.

[0097] The Faraday-rotation child 32 includes a magneto optics crystal 41, the permanent magnet 42 and electromagnet 43 which impress a magnetic field in the direction which intersects perpendicularly mutually to a magneto optics crystal 41, and the source 44 of a good transformation style which gives drive current to an electromagnet 43.

[0098] Drive current can be small suppressed by using YIG (yttrium iron garnet) started thinly and the 3 (GdBi) 5 (FeAlGa) O12 grade which carried out the epitaxial crystal growth as a magneto optics crystal 41.

[0099] The thickness direction of a magneto optics crystal 41 is parallel to the Y-axis, and the direction of the magnetic field impressed to a magneto optics crystal 41 with a permanent magnet 42 and an electromagnet 43 in this case is parallel to the Z-axis and the X-axis respectively. The sign 45 expresses the light beam which penetrates a magneto optics crystal 41.

[0100] Drawing 26 is drawing for explaining the direction and strength (size) of magnetization. [the magnetic field given to a magneto optics crystal 41 in the Faraday-rotation child 32 shown in drawing 25, and a magneto optics crystal 41]

[0101] When the magnetic field vector 51 is now impressed to the magneto optics crystal 41 only with the permanent magnet 42, the magnetization vector of a magneto optics crystal 41 becomes parallel to the Z-axis, as shown by the sign 52. The impression magnetic field strength at this time (the length of a magnetic field vector 51) is set up so that the intensity of magnetization (the length of the magnetization vector 52) of a magneto optics crystal 41 may be saturated.

[0102] And the greatest Faraday-rotation angle required of this state shall be acquired, for example. If a magnetic field vector 53 is impressed in parallel with the X-axis with an electromagnet 43, a synthetic magnetic field will serve as a synthetic vector of magnetic field vectors 51 and 53, as shown by the sign 54. In a magneto optics crystal 41, the magnetization vector 55 arises by this synthetic magnetic field 54. The magnetization vector 55 and the magnetic field vector 54 are mutually parallel, and length's of the magnetization vector 55 correspond with the length of the magnetization vector 52.

[0103] The degree of contribution of the magnetization to the Faraday-rotation angle which a magneto optics crystal 41 gives is not necessarily the same just because the intensity of magnetization of a magneto optics crystal 41 is fixed. It is because a Faraday-rotation angle is dependent also on the relation between the direction of the magnetization concerned, and the propagation direction of light.

[0104] That is, if the state where the state where the magnetization vector 52 has arisen, and the magnetization vector 55 have arisen is compared, only in the part to which the Z component 56 of the magnetization vector 55 is decreasing to Z component (magnetization vector 52 itself) of the magnetization vector 52, the latter Faraday-rotation angle will become small.

[0105] According to this operation gestalt, since the intensity of magnetization of a magneto optics crystal 41 will always be saturated over all the ranges of the adjustable range of a Faraday-rotation angle, un-arranging resulting from many magnetic domains being formed in a magneto optics crystal 41 does not arise. That is, the repeatability of a Faraday-rotation angle becomes good and adjustable [**** / a Faraday-rotation angle] becomes possible.

[0106] Moreover, by adjusting the drive current supplied from the source 44 of a good transformation style, since a Faraday-rotation angle can be changed with continuously and sufficient repeatability, by applying the Faraday-rotation child 32 to this invention, high-speed operation is possible and offer of a reliable good light variation study filter is attained.

[0107] Therefore, offer of the good light variation study filter in which adjustable [with the sufficient repeatability of the wavelength property of permeability / of a wavelength property / continuous] is possible is attained by applying such an adjustable Faraday-rotation child to this invention.

[0108] Drawing 27 is drawing showing other Faraday-rotation child 32' applicable to this invention. A different point from the Faraday-rotation child 32 by whom Faraday-rotation child 32' is shown to drawing 25 is a point of forming the parallel flat surfaces 61 and 62 in the vertical angle which a magneto optics crystal 41 faces mutually, and making it a light beam 63 pass these

flat surfaces 61 and 62. Therefore, the direction of a magnetic field by the permanent magnet 42 and the direction of the magnetic field by the electromagnet 43 incline 45 degrees of outlines to both the propagation directions (parallel to the Z-axis) of light.

[0109] Drawing 28 is drawing for explaining the direction and strength of magnetization [the magnetic field given to a magneto optics crystal 41 in Faraday-rotation child 32' shown in drawing 27 , and a magneto optics crystal 41]

[0110] The magnetic field impressed with an electromagnet 43 can adjust strength and the sense in the range of the state by which it is shown with a sign 72 from the state shown with a sign 71. The sign 73 shows the impression magnetic field by the permanent magnet 42.

[0111] In this case, about a synthetic magnetic field, the strength and direction change in the range between the states where it is expressed with the state where it is expressed with a sign 74, and a sign 75. In connection with this, the strength and direction change from the state shown with a sign 76 also about magnetization of a magneto optics crystal 41 in the range of the state by which it is shown with a sign 77.

[0112] The adjustable range of a Faraday-rotation angle can be enlarged without enlarging adjustable width of face of the drive current of an electromagnet 43 so much, if such a Faraday-rotation child 32 is used.

[0113] In addition, the impression magnetic field by the permanent magnet 42 is set up so that the intensity of magnetization of a magneto optics crystal 41 may be enough saturated with the state (the impression magnetic field by the electromagnet 43 is the state of 0) by which it is shown with the sign 78 from which intensity of magnetization becomes the minimum.

[0114] Drawing 29 is drawing showing 32" of adjustable Faraday-rotation children of further others who can apply to this invention. The point that 32" of Faraday-rotation children differs from the Faraday-rotation child 32 of drawing 25 is a point of having replaced with the permanent magnet 42 of drawing 25 , having formed the electromagnet 81, and having formed the source 82 of a good transformation style which gives drive current further to an electromagnet 81.

[0115] Drawing 30 is drawing for explaining the direction and strength of magnetization. [the magnetic field given to a magneto optics crystal 41 in 32" of Faraday-rotation children shown in drawing 29 , and a magneto optics crystal 41]

[0116] According to the operation gestalt of drawing 29 , it can be made to change by adjusting the impression magnetic field by electromagnets 43 and 81, keeping saturation magnetization continuous in a synthetic magnetic field, as shown in a sign 91 or 94. In connection with this, magnetization of a magneto optics crystal 41 changes continuously, as shown in a sign 95 or 98.

[0117] Thus, the adjustable range of a Faraday-rotation angle can be enlarged easily, without using the magneto optics crystal of a complicated configuration as shown in drawing 27 according to the operation gestalt of drawing 30 .

[0118] Moreover, since the sense of Z component of magnetization of a magneto optics crystal 41 can be changed by switching the source 44 of a good transformation style, or the polarity of the impression magnetic field, as shown in a sign 91 or 94. In connection with this, magnetization of a magneto optics crystal 41 changes continuously, as shown in a sign 95 or 98.

[0119] Therefore, by applying 32" of Faraday-rotation children to this invention, as mentioned above, for example, when a Faraday-rotation angle is 0 degree by setting it as $\Delta\theta = \phi$ or $\Delta\theta = -\theta$, permeability is not based on wavelength but becomes fixed. For example, since a Faraday-rotation angle becomes 0 degree when 32" of Faraday-rotation children is included in a system, and the sources 44 and 82 of a control off next door good transformation style are turned off, permeability is not based on wavelength, but becomes fixed, and re-starting of a system etc. becomes easy.

[0120] drawing 31 shows the 10th operation form of the good light variation study filter by this invention -- it comes out With this operation form, the wedge boards 121 and 122 which consist of birefringence matter as the 1st polarizer P1 and 2nd polarizer P2, respectively are used. In connection with this, the light beam which converged with the lens 124 for changing the beam parameter and supplying the light emitted from the optical fiber 123 and the optical fiber 123 to

the wedge (collimating, for example) board 121, the lens 125 for converging the beam from the wedge board 122, and the lens 125 has formed additionally the optical fiber 126 combined with the bottom of predetermined conditions.

[0121] The wedge boards 121 and 122 are arranged so that the fields to which the crowning and pars basilaris ossis occipitalis of the wedge board 121 counter and correspond to the pars basilaris ossis occipitalis and crowning of the wedge board 122, respectively may become parallel mutually. That is, the wedge boards 121 and 122 have the same configuration.

[0122] The optical axis of the wedge board 121 is parallel to a Y-axis, and the optical axis of the wedge board 122 is parallel to a Y-axis. The transparency shaft of the rust boards 121 and 122 which go away as a polarizer is defined as the polarization direction of an extraordinary ray with plane of polarization parallel to an optical axis, or a polarization direction of an ordinary ray with plane of polarization perpendicular to an optical axis.

[0123] The light emitted from the excitation edge of an optical fiber 132 is collimated by the lens 124, and becomes an parallel light beam. This beam disregards a beam size and is expressed with a sign 130. A beam 130 is divided into the beam 131 which is equivalent to the ordinary ray in the wedge board 121, and the beam 132 equivalent to an extraordinary ray.

[0124] Beams 131 and 132 pass a birefringent plate BP and the adjustable Faraday-rotation child FR in this order, and turn into beams 133 and 134, respectively. The polarization state of beams 133 and 134 is determined according to the Faraday-rotation angle given by the Faraday-rotation child FR.

[0125] A beam 133 is divided into the beams 135 and 136 which carry out considerable to the ordinary ray and extraordinary ray in the wedge board 122, respectively. A beam 134 is divided into the beams 137 and 138 which carry out considerable to the extraordinary ray and ordinary ray in the wedge board 122, respectively.

[0126] If a beam 135 or 138 takes into consideration the configuration and arrangement form of the history of refraction and the wedge boards 121 and 122 which have received, respectively, beams 135 and 137 are mutually parallel, and that of beams 136 and 138 are not mutually parallel. Therefore, only beams 135 and 137 can be narrowed down with a lens 125, and it can combine with the excitation edge of an optical fiber 126.

[0127] Now, the ratio of the total power of beams 135 and 137 and the total power of beams 136 and 138 is dependent on the Faraday-rotation angle given by the Faraday-rotation child FR, the case where beams 133 and 134 are the linearly polarized lights which have the respectively same plane of polarization as beams 131 and 132 -- each of beams 133 and 134 -- all are changed into beams 135 and 137

[0128] Moreover, when beams 133 and 134 are the linearly polarized lights which have the plane of polarization which intersects perpendicularly with the plane of polarization of beams 131 and 132, respectively, beams 133 and 134 are all changed into beams 136 and 138, respectively.

[0129] On the other hand, in the state where the Faraday-rotation angle given by the Faraday-rotation child FR is fixed, the total power of beams 135 and 137 is not dependent on the polarization state of a beam 130. It is clear from old explanation that the total power of beams 135 and 137 is dependent on those wavelengths.

[0130] Therefore, the permeability of a good light variation study filter can be prevented from being dependent on the polarization state of input light according to this operation form. That is, offer of a non-dependent polarization good light variation study filter is attained.

[0131] Drawing 32 is drawing showing the 11th operation form of the good light variation study filter by this invention. Here, the wedge board 141 which consists of birefringence matter as the 1st polarizer P1 is used, and the rust boards 142 and 143 which consist of birefringence matter as the 2nd polarizer P2 and which go away two are used.

[0132] The crowning and bottom of the wedge board 141 countered the bottom and crowning of the wedge board 142, respectively, and the crowning and bottom of the wedge board 143 have countered the bottom and crowning of the wedge board 142, respectively.

[0133] And when setting to θ_1 , θ_2 , and θ_3 the wedge board 141, 142 and the rust angle which goes away 143, respectively, setting distance between the wedge board 141 and 142 to d1 and setting distance between the wedge board 142 and 143 to d2, each wedge board is

produced and arranged so that the following two formulas may be satisfied.

[0134]

$\theta = \theta_1 + \theta_2$ The optical axis of the d1 sintheta1=d2 sintheta3 wedge board 141 is parallel to the Y-axis, and the optical axis of the wedge boards 142 and 143 is mutually parallel. The optical axis of the wedge boards 142 and 143 is parallel to the Y-axis.

[0135] With the operation form of drawing 31, in order to form a birefringent plate BP and the Faraday-rotation child FR between the wedge board 121 and 122, distance between the wedge board 121 and 122 must be enlarged comparatively. Therefore, the distance between a beam 135 and 137 also becomes comparatively large, and it becomes easy to be influenced of aberration, such as spherical aberration of a lens 125.

[0136] Incidence can be efficiently carried out to an optical fiber 126, without influencing

[most] these of the aberration with a lens 125, since the optical path of an ordinary ray component [which is outputted from the wedge board 143 when polarization separation of the beam from a lens 124 is carried out with the wedge board 141 when based on the operation form of drawing 32, and polarization composition is carried out with the wedge boards 142 and 143]. and extraordinary-ray component is mostly in agreement.

[0137] Drawing 33 is drawing showing the 12th operation form of the good light variation study filter by this invention. Here, the plates 151 and 152 which consist of birefringence matter as the 1st polarizer P1 and 2nd polarizer P2, respectively are used.

[0138] The thickness of plates 151 and 152 is equal. The optical axis of plates 151 and 152 is set up so that it may intersect perpendicularly mutually for example, and 45 degrees of each optical axis may incline to the Z-axis, respectively.

[0139] Each transparency shaft of the plates 151 and 152 as a polarizer is defined as the polarization direction of an extraordinary ray with plane of polarization parallel to an optical axis, or a polarization direction of an ordinary ray with plane of polarization perpendicular to an optical axis. The light emitted from the excitation edge of an optical fiber 123 becomes the beam 160 which the beam parameter is changed with a lens 124, for example, is converged. A beam 160 is divided into the beams 161 and 162 which carry out considerable to the ordinary ray and extraordinary ray in a plate 151, respectively. Beams 161 and 162 are mutually parallel.

[0140] Beams 161 and 162 pass a birefringent plate BP and the Faraday-rotation child FR in this order, and turn into beams 163 and 164, respectively. The polarization state of beams 163 and 164 is determined according to the Faraday-rotation angle given by the Faraday-rotation child FR.

[0141] A beam 163 is divided into the beams 165 and 166 which are equivalent to the ordinary ray and extraordinary ray in a plate 152. A beam 164 is divided into the beams 167 and 168 which are equivalent to the ordinary ray and extraordinary ray in a plate 152.

[0142] Since plates 151 and 152 are mutually parallel and its thickness of these Z shaft orientations is equal, a beam 165 is in agreement with a beam 168. Therefore, only beams 165 and 168 can be narrowed down with a lens 125, and incidence can be carried out to an optical fiber 126.

[0143] Now, the ratio of the total power of beams 165 and 168 and the total power of beams 166 and 167 is dependent on the Faraday-rotation angle given by the Faraday-rotation child FR.

[0144] On the other hand, in the state where the Faraday-rotation angle given by the Faraday-rotation child FR is fixed, the total power of beams 165 and 168 is not dependent on the polarization state of a beam 160. It is clear from old explanation that the total power of beams 165 and 168 is dependent on those wavelength.

[0145] Therefore, offer of a non-dependent polarization good light variation study filter is attained also according to this operation form. In addition, when using the plate which consists of birefringence matter as each polarizer, various arrangement forms can be adopted by preparing 1/2 wavelength plate additionally.

[0146] (A) of drawing 34 and (B) are drawings for explaining the 13th operation form of the good light variation study filter by this invention. Although it corresponds to the 10th operation form of drawing 31 and is shown in (B) of drawing 34, the 13th operation form is shown in (A) of drawing 34.

[0147] In (A) of drawing 34, each degree of polarization part elongation or wedge angle of the wedge boards 121 and 122 is theta', and beams 135 and 137 do not combine beams 136 and 138 with an optical fiber 126 to combining with an optical fiber 126 with a lens 125.

[0148] Here, as shown in (B) of drawing 34, wedge board 121' and 122' which have angle theta' smaller than angle theta' respectively shall be used. At this time, beam 135' or 138' is outputting from wedge board 122'. Beam 135' and 137' are all theoretically combined with an optical fiber 126 with a lens 125. Here, a part of beam 136' by which making it combine with an optical fiber 126 originally is not planned, and 138' may be combined with an optical fiber 126 according to angle theta' being smaller than angle theta'. If that is right, the effect same with having used the partially polarized light child as the 2nd polarizer P2 will arise.

[0149] The conditions which a part of beam 136' and 138' combine with an optical fiber 126 are given by $\alpha/\sin\theta$, when setting the focal distance of a and a lens 125 to f for the core diameter of an optical fiber 126.

[0150] By satisfying this condition, average dissipation of a good light variation study filter can be made small the same with having used the partially polarized light child as the 2nd polarizer P2. As mentioned above, although this invention was explained based on various operation forms, you may carry out this invention more than combining two or it of an old operation form.

[0151]

[Effect of the Invention] As explained above, according to this invention, the effect that offer of a good light variation study filter from which the configuration of the property straight line which gives the wavelength property of permeability changes to the shaft orientation of permeability is attained arises. Other effects by this invention are clear from the above explanation.

[Translation done.]

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*** NOTICES ***

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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] Drawing 1 is explanatory drawing of a birefringent filter (the conventional technology).

[Drawing 2] (A) of drawing 2 and (B) of drawing 2 are drawings for explaining the example of the property of the conventional good light variation study filter.

[Drawing 3] (A) of drawing 3 and (B) of drawing 3 are drawings for explaining the example of the property of a good light variation study filter demanded.

[Drawing 4] the member of the birefringent filter drawing 4 is indicated to be to drawing 1 — it is drawing showing the physical relationship of a between

[Drawing 5] Drawing 5 is explanatory drawing [having approximated by the linear function $(1/\lambda)$].

[Drawing 6] Drawing 6 is drawing showing change of the wavelength property of the permeability when changing theta defined by drawing 4 .

[Drawing 7] the [of the good light variation study filter according / respectively (A) of drawing 7 and (B) of drawing 7 / to this invention / the 1st and] — it is drawing showing 2 operation gestalten

[Drawing 8] the member in each operation gestalt of the good light variation study filter according [drawing 8] to this invention — it is drawing showing the physical relationship of a between

[Drawing 9] Drawing 9 is a graph which shows the 1st example of the wavelength property of permeability.

[Drawing 10] Drawing 10 is explanatory drawing of a loss inclination.

[Drawing 11] Drawing 11 is a graph which shows the 2nd example of the wavelength property of permeability.

[Drawing 12] (A) of drawing 12 and (B) of drawing 12 are graphs which show the 3rd example of the wavelength property of permeability.

[Drawing 13] Drawing 13 is a graph which shows the 4th example of the wavelength property of permeability.

[Drawing 14] the [of the good light variation study filter according / respectively (A) of drawing 14 and (B) of drawing 14 / to this invention / the 3rd and] — it is drawing showing 4 operation gestalten

[Drawing 15] Drawing 15 is a graph which shows the 5th example of the wavelength property of permeability.

[Drawing 16] Drawing 16 is a graph which shows the 6th example of the wavelength property of permeability.

[Drawing 17] Drawing 17 is drawing showing the 5th operation gestalt of the good light variation study filter by this invention.

[Drawing 18] Drawing 18 is drawing showing the 7th example of the wavelength property of permeability.

[Drawing 19] Drawing 19 is drawing showing the 6th operation gestalt of the good light variation study filter by this invention.

[Drawing 20] Drawing 20 is drawing showing the example of the octavus of the wavelength property of permeability.

[Drawing 21] Drawing 21 is drawing showing the 7th operation gestalt of the good light variation study filter by this invention.

[Drawing 22] Drawing 22 is drawing showing the octavus operation gestalt of the good light variation study filter by this invention.

[Drawing 23] Drawing 23 is drawing showing the 9th operation gestalt of the good light variation study filter by this invention.

[Drawing 24] (A) of drawing 24 and (B) of drawing 24 are graphs which show the example of the wavelength property of permeability with the good light variation study filter shown in drawing 23 .

[Drawing 25] Drawing 25 is drawing showing the Faraday-rotation child who can apply to this invention.

[Drawing 26] Drawing 26 is a magnetic field in drawing 25 , and explanatory drawing of magnetization.

[Drawing 27] Drawing 27 is drawing showing other Faraday-rotation children who can apply to this invention.

[Drawing 28] Drawing 28 is a magnetic field in drawing 27 , and explanatory drawing of magnetization.

[Drawing 29] Drawing 29 is drawing showing the Faraday-rotation child of further others who can apply to this invention.

[Drawing 30] Drawing 30 is a magnetic field in drawing 29 , and explanatory drawing of magnetization.

[Drawing 31] Drawing 31 is drawing showing the 10th operation gestalt of the good light variation study filter by this invention.

[Drawing 32] Drawing 32 is drawing showing the 11th operation gestalt of the good light variation study filter by this invention.

[Drawing 33] Drawing 33 is drawing showing the 12th operation gestalt of the good light variation study filter by this invention.

[Drawing 34] (A) of drawing 34 is drawing showing the good light variation study filter corresponding to drawing 31 , and (B) of drawing 34 is drawing showing the 13th operation gestalt of the good light variation study filter by this invention.

[Description of Notations]

P1 The 1st polarizer

P2 The 2nd polarizer

BP Birefringent plate

FR Adjustable Faraday-rotation child

[Translation done.]